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Community-based monitoring A Strategy for Public Engagement in Natural Resource Issues

Paul Beĺ?langer
The University of Montana

COMMUNITY-BASED MONITORING

A Strategy for Public Engagement in Natural Resource Issues

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Paul Belanger

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Chairperson

Dean

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Introduction

Natural resource issues in the West are typically characterized as contentious and complex (McKinney and Harmon 2004). Land management agencies are challenged to meet the complex and often competing information, economic, and social demands while working under a management paradigm that emphasizes the use of the best available science to guide land management decision. First introduced in the early 1900's, scientific management theory offered a rational, efficient, and objective measure for guiding natural resource management decisions (McKinney and Harmon 2004). The notion of scientific experts guiding land management decisions afforded science a prominent role in public land management agencies and in turn, natural resource disputes increasingly relied on science to resolve disputes. However, the narrow focus of science limits its ability to address the multiple dimensions of these disputes. As a result, natural resource management decision-making processes under the scientific management paradigm could never fully separate itself from the politics of these issues and the science became more "politicized" (Eden, 1996, p. 189; McKinney and Harmon 2004). Although scientific management theory is one of the best available tools to address the complex ecological dimensions of natural resource disputes, equally effective tools are needed to address the social dimensions of these issues. Without, public land management becomes susceptible to an increasing number of political special interests and in turn, "walks a fine line between preservation and exploitation" (Stegner, 1992, p.82).

A strategy to address the influence of social and political demands on science and resource management is to make decision-making processes more inclusive. Consequently, there is a growing movement to include all stakeholders in a natural resource dispute in the decision-making process as a way to educate the public about the complex nature of natural resource issues (Fischer 2000; McKinney and Harmon 2004). It is hoped that these strategies will raise awareness of the ecological and other dimensions of public land management, facilitate dialogue, and help build trust and support for land management decisions (Irwin 1995; Au et al. 2000; McKinney and Harmon 2004). Attempts for more public participation at all levels of natural resource decision-making processes, including final authority over decisions, are challenged however, by a structure in public land management agencies that centralizes authority at the highest levels of government. Therefore, many public participation efforts attempt to realize the benefits of more inclusiveness and influence decisions by functioning under the current decision-making paradigm without directly challenging the authority of public land management agencies (Pollack 2003). The Bitterroot Community-based Monitoring (CBM) project is an example of such a strategy. I designed the program to engage, educate, and raise awareness in the public about the ecological dimensions of a contentious natural resource issue through participation in a science-based ecological monitoring program.

The CBM project evolved from a convergence of perceived public and U.S. Forest Service interests. First, standing dead timber that result's from fire provides critical habitat for a variety of priority bird species like the Lewis's Woodpecker (*Melanerpes lewis)*, Black-backed Woodpecker (*Picoides arcticus)*, and American Three-toed Woodpecker (*Picoides tricdactylus*) (Montana Partners in Flight 2000). Thus, there is an interest in the conservation community and public land managers (i.e. U.S. Forest Service) to develop management guidelines to protect this habitat. Second, ecosystem management mandates of the U.S. Forest Service direct public land managers to use the best available science for meeting the management needs of public lands (McKinney and Harmon 2004). In other words, understanding the ecological dimensions of the importance of post-fire habitat for birds is essential for guiding public land management policy. Third, that land managers are addressing complex social issues in addition to complex ecological issues. The social issues were defined, in part, by intense public demand for protection of communities from forest fires, and by economic/industry demands for access to some of the burned timber resources that resulted from the Bitterroot fires of 2000. Fourth, public education and outreach programs are critical in order to build support for environmentally responsible natural resource decisions. And finally, ecological monitoring to understand the effects of land management activities is supported by public land managers as an important part of overall ecosystem management objectives; however, with tightening budgets, ecological monitoring is often pushed aside.

This project examines the Bitterroot CBM program to better understand the ability of CBM programs to meet multiple complimentary objectives in conservation, education, and science research. This project sought to answer the following questions. Are CBM projects an effective tool for increasing public awareness and understanding of the multiple dimensions of natural resource disputes, and if so, what are the benefits to participants in the Bitterroot CBM project? Can CBM projects overcome issues of scientific accuracy to become a resource for science and land managers to fulfill ecosystem-monitoring needs? And is there value beyond the benefits to individual participants that a CBM project can contribute to understanding and resolving natural resource disputes? The following section reviews public participation theory providing a framework for guiding the design and evaluation of the Bitterroot CBM project. Review of the methods and results of the volunteer and monitoring program is followed by a discussion of the efficacy and challenges for building future CBM projects. Public participation together with environmental education theory provide a framework that is useful in assessing the link between participant learning outcomes and an increased capacity in participants to support and contribute to sustainable land management activities in the post-fire landscape.

Literature Review

The Nature of Natural Resource Disputes

Both research and conservation professionals concur that natural resource disputes result in part from the challenges that land management agencies face in meeting the complex information, economic, and social demands of the public while working under conflicting and competing missions (McKinney and Harmon 2004). The first architects of public land management agencies, influenced by the rise of science and technology during the industrial revolution, instituted scientific management theory as a rational, efficient, and objective measure for resource use and management decisions (McKinney and Harmon2004). The notion that land management decisions should be guided by experts, placed science in a position of authority over natural resource disputes. Although science has provided invaluable information about natural systems, its narrow focus limited its ability to address the multiple (interdisciplinary) dimensions of natural resource disputes (Irwin 1995; Clark 1997). The centralized authority of public land agencies, the specialized discipline of science, and the challenge of public access to scientific information limit the opportunity for meaningful public engagement in decision-making processes (Orr 1992; Irwin 1995). As a result, natural resource management under the scientific paradigm could never fully separate itself from the politics of these issues (Eden 1996; McKinney and Harmon 2004). A full-page advertisement posted in the *Missoulian* during the 2003 fire season by a political group called <u>Project Protect</u> reflects the political framing of forest and fire management:

> "Questions:
> - How much more environmental destruction can we take?
> - How many more acres of critical wildlife habitat must be destroyed?
> - How many rivers, streams and lakes must be polluted?

- How many days must Montana residents breathe in smoke from the fires?
- How many more fire fighters need to risk their lives?

Answer:

The Healthy Forests Restoration Act"

(Missoulian, September 18, 2003).

Without a clear distinction of science and politics, natural resource management fell victim to competing interests, values, and power structures. Public distrust and disengagement in decision-making processes is perpetuated by the inability to effectively engage those affected by land management decisions. As Wallace Stegner states, the public, most notably the environmental community views the U.S. Forest Service "not as the protector of an invaluable public resource and the true champion of multiple use, but as one of the enemy, allied with timber interests" (Stegner 1992, p. 83).

The Case for Public Participation

Recognizing the complex ecological and social dimensions of natural resource disputes and the limitations of science alone in interpreting and resolving these issues are two factors driving efforts to identify new approaches to resolving land management issues. As Daniel Botkin writes:

> Solving our environmental problems requires a new perspective that goes beyond science and has to do with the way that everyone perceives the world...in order to gain a new view, one necessary to deal with global environmental problems, we must break free of old assumptions and old myths about nature and ourselves... (Botkin 1990, p. 5).

In effect, Botkin, and many others (Orr 1992, 1994; Irwin 1995) support a fundamental reframing of how society (particularly western society) views its relationship with the natural world. In part, this sort of reframing will require changes to our economic, political, and academic institutions. While there are currently attempts in education and politics for institutional reform, the process is time consuming, costly, and in many cases unfeasible. Many natural resource issues require more immediate attention, and typically, the political will or means needed for reform is not present (Bliss et al 2001). Therefore, people involved with natural resource disputes are working diligently to develop strategies that function within the current scientific management paradigm. One strategy emerging is more public engagement in decision-making processes.

Public participation in decision-making processes is increasingly being used to address the issues of trust (Irwin 1995; Au et al 2000), public engagement in land management (Bliss et al 2001), and the challenges of bridging ecological knowledge or scientific facts with social values (Cuthill 2000; Bliss et al 2001). Regional, local, and grassroots organizations are bringing this collaborative approach to the forefront of natural resource dispute resolution in the 21st century (McKinney and Harmon 2004). Arnstein's ladder of public participation (Table 1) illustrates the multiple levels of collaboration in decision-making processes (Stadel and Nelson 1995):

Table 1 – Arnstein's Ladder of Public Participation (adapted from Arnstein 1969 in Hodge 1991, p.364)

Citizen control	**Citizens govern the program**
Delegated power	**Dominant decision-making by citizens**
Partnership	**Agreement to share responsibilities**
Placation	**Citizens are heard but not heeded**
Consultation	**Explicit means used to obtain views of citizens**
Informing	**Communication of plans TO citizens**
Therapy	**Engaging citizens in diversionary activities**
Manipulation	**Citizens are persuaded to support the plan**

Realizing the benefits of public participation is determined, in part, by the level of inclusiveness a public participation approach adopts. An approach that engages the public at all levels of environmental planning and management has the capacity to realize the following benefits:

- increased ownership and support for environmental solutions (Heiman 1997; Au et al 2000),
- extending knowledge networks beyond formal scientific interpretations of environmental problems to include local knowledge leads to more creative and effective solutions to environmental problems (Clark and Murdoch 1997);
- participation in the data-gathering and information-dissemination processes builds partnerships between the community and agencies, facilitates dialogue, builds social capital – cooperative networks – raises awareness of environmental issues and develops skills that enable citizens to help meet further monitoring needs and/or policy development within communities (Au et al 2000; Bliss et al 2001; Pollack 2003).

However, not all strategies are capable of full public participation due to institutional obstacles. Some efforts attempt to include the public at one or more levels. Through Congress and the passage of laws such as the National Environmental Policy Act, the Forest and Rangeland Renewable Resources Planning Act, the National Forest Management Act, and the Federal Land Policy and Management Act (McKinney and Harmon 2004), public participation is solicited to comment on expert driven alternatives to management. These attempts are often effective yet, like many public participation strategies, are incomplete. Due to centralized authority and the limits of current public involvement in decision making processes, final decisions are often viewed with skepticism.

There is no cookie-cutter strategy for effective public participation programs. Public participation strategies, like the complex nature of environmental disputes, will reflect the particular intricacies of place, people, and local conditions. Still, numerous case studies that have adopted inclusive, community-based processes for ecosystem management provide evidence in support of continuing to develop ways and means for the effective public engagement in decision-making processes (Gray et al. 2001).

Public Participation Theory and Community-Based Monitoring

It has become widely recognized that for goals of sustainability to be reached, efforts to connect individuals and groups around issues that reflect a common concern are central to building community capacity for support of decisions and the development of creative and effective long-term solutions (Clark and Murdoch 1997; Ecological Monitoring and Assessment Network 2002). Community-based monitoring programs are being applied with increasing regularity as an attempt to include the public at the level of monitoring, information gathering, and dissemination to serve the needs of decision-makers, scientists, non-governmental organizations (NGOs), and educators. The demand for these programs is driven by a number of factors: recognition that volunteers can help meet the needs of science to help identify conservation priorities (e.g. Christmas Bird Counts), increasing public mistrust of government agencies and science (Irwin 1995; Au et al 2000), the growing recognition that social complexities surround many environmental issues (Bliss et al 2000, Cuthill 2000), and demands from the public for more inclusiveness in developing the land-management policies that directly affect their quality of life (Bliss et al 2000). Government support of environmental programs in many countries has also declined, prompting NGOs, scientists, communities, and other organizations to develop innovative models to meet ecosystem-monitoring needs (Francis 1991; Lee 1994; Au et al 2000). Although the engagement of citizens in ecosystem monitoring is perceived as an emerging trend, it is hardly a new concept. The *National Directory of Volunteer Environmental Monitoring Programs* (1994) reported more than 500 volunteer monitoring programs in the United States (Kerr 1994a). In 2004, the National Audubon Society completed their 104th annual Christmas Bird Count, where more than 55,000 volunteers counted more than 2,400 species of birds across the Americas over a two-week period adding to a database used by researchers to guide and develop bird conservation programs (LaBaron 2004). Pollack (2003) identifies four types of CBM programs:

1. Programs that strive to "complement the actions of scientific experts" (Stadel and Nelson 1995);
2. Programs to emphasize the "educational aspects of monitoring through participation" (Cuthill 2000);
3. Advocacy monitoring focused on a particular issue that emphasizes a particular action;
4. Multiparty monitoring that is associated with collaborative efforts to bridge the social and ecological dimensions of problems and strive to influence decisions through cooperation as opposed to advocacy.

Stadel and Nelson (1995) recognize that "in monitoring [programs], different levels of participation are also related to different levels of control that the participants have over the process (p. 412)". Like Arnstein's governance ladder of public participation, with more inclusiveness in monitoring programs comes an increased potential to realize the full benefits of public participation – public trust, support, and increased public access to expert information. Stadel and Nelson (1995) developed a CBM ladder of public participation to illustrate this point (Table 2).

Table 2 – Ladder of Community-based Monitoring

Community-based	**Citizens govern the program**
Partnerships	**Community is part of a monitoring network**
Planning	**Involvement in defining purpose and scope**
Data Management	**Data is stored and managed by community**
Data Collection	**Citizens collect data for an organization**
Information	**Citizens are informed about monitoring project**

CBM programs are not without challenges. When the public is involved in gathering data, questions of scientific rigor and data accuracy are raised (Heiman 1997; Au et al 2000; Bliss et al 2001). Typically, student-science or public-science partnerships are implemented to meet multiple complimentary objectives in environmental education (Lewenstein 1994; Trumball 2000; Sharpe 2000; Buff 2001; LaBranche 2001), science literacy (Irwin 1995), and conservation (Bliss et al 2001, Lewenstein 2004). Skepticism of scientific rigor and data accuracy often forces student-driven CBM programs to choose process (i.e. learner) versus product (i.e. data) outcomes.

> Student-science partnerships tend to either (1) generate student collected data at the request of a research organization that is able to validate and utilize the data (at the expense of student inquiry), or (2) provide science methods training to schools, but without the rigors or demands of generating publishable data (Buff 2001, p. 9).

Another challenge is presented not by the process of implementing a credible project but rather, by its outcomes. Monitoring alone is not an outcome, but if applied to understanding the effects of land management activities, monitoring outcomes may influence land management activities. Consequently, this level of accountability may result in change to the status quo and challenge those in authority and thus raise unanticipated fears and concerns (Bliss et al. 2001).

Monitoring networks are also implemented as part of a bottom-up or grassroots approach to resolving natural-resource issues. However, public participation does not always equate to stronger grassroots work and capacity (Rahman 1995; Pollack et al. 2003), highlighting the challenge of transferring public knowledge and awareness into a change in individual behavior. It is also difficult to maintain public engagement due to citizen "bias for certain projects, a lack of interest and ownership and lack of resources to continue projects" (Pollack et al. 2003).

These issues present the challenges of implementing successful CBM programs. A number of lessons can be taken from public participation theory and other CBM programs. In Canada, a partnership between government and the private sector has established a national community-based monitoring program. This program is defined as a process where concerned citizens, government agencies, industry, academia, community groups, and local institutions collaborate to monitor, track, and respond to issues of common community concern (Canadian Community Monitoring Network 2002). Emphasis is placed on monitoring designed to promote sustainability, community leadership, and use of monitoring data to inform decision making (Ecological Monitoring and Assessment Network 2002). The Canadian model provides theoretical support and concrete recommendations for building successful community monitoring programs. The development of this program was guided by the following recommendations (Canadian Community Monitoring Network 2000):

1. Secure adequate funding and commitment prior to initiation of monitoring activities (Long Point World Biosphere Reserve Foundation 2002).
2. Provide feedback to volunteers on how their work contributes to planning and management (Stadel and Nelson 1995).
3. Understand participant motivations and skill level and match to the monitoring protocols selected (Cuthill 2000; Bliss et al 2001).
4. Collaborate with organizations already monitoring through partnership development (Long Point World Biosphere Reserve Foundation 2002).
5. Utilize simple and scientifically tested methodologies (Au et al 2000).
6. Incorporate training on monitoring protocols, field supervision, and verification of monitoring data into the design of CBM (Stokes et al 1990; Stadel and Nelson 1995; Au et al 2001).
7. Establish a volunteer recognition program (Stadel and Nelson 1995).
8. Focus on outcomes that serve society through the delivery of policy relevant information (Vaughan 2002).

Attending to these guidelines can be useful in guiding the development of community-based monitoring programs in other places.

Not reflected above, though, are the meaningful educational benefits that community-based monitoring programs provide. Monitoring programs, like any other research, provide opportunities to observe in detail changes and patterns on the landscape. This type of experience is often noted in environmental education materials as essential to building deeper understanding, knowledge, and skills in the learner. Furthermore, the personal connections established to the place (river, forest, grassland, pond) through long-term participation foster a deeper connection to that place - an important prerequisite for developing more environmentally responsible behavior (Disinger 2002). Thus, CBM programs provide meaningful, hands-on, and engaging learning opportunities that affect the potential for participants making more environmentally responsible public and private decisions.

Community-based Monitoring in the Bitterroot Valley

Guiding the development of the monitoring focus of the Bitterroot CBM project was the desire to engage community volunteers in a project that generated information relevant to an issue of common community concern and contributed to the understanding of how forest fires and land management activities affect bird communities. Monitoring the nesting success of cavity-nesting birds in recent (1-5 years) burned logged and unlogged forests met this objective for the following reasons. First, there is increasing evidence that standing dead timber as a result of fire is critical habitat for a number of priority bird species such as the Black-backed Woodpecker (Montana Partners in Flight 2000). Some species of cavity-nesting birds are apparently restricted to the conditions created by stand-replacement fires (Hutto 1995a, Hutto and Young 1999). A number of studies have examined the suitability of burned and unburned forests to cavity-nesting birds for nesting and foraging (Caton 1996, Hitchcox 1996, Saab and Dudley 1998, Hejl and McFadzen 2000). Results indicate that even some widespread species like American Robin (*Turdus migratorius*) and Hairy Woodpecker (*Picoides villosus*) show a preference for burned forests for nesting and/or foraging (Hutto and Young 1999). Other studies of cavity-nesting birds in logged and unlogged burned forests indicate that certain species like the Black-backed Woodpecker show a preference for unlogged conditions in severely burned mixed-conifer forests (Caton 1996; Hitchcox 1996; Saab and Dudley 1998; Kotliar et al. 2002). Conversely, other species including cavity-nesting birds like the Lewis's Woodpecker, American Kestrel (*Falco sparverius*), and Mountain Bluebird (*Sialia currucoides*) favor some conditions created by post-fire logging (i.e. salvage logging) prescriptions (Saab and Dudley 1998, Saab et al 2000; Hejl and McFadzen 2000). However, just four studies have examined the nesting success of birds in burned and unburned conditions (i.e. Caton 1996, Hitchcox 1996, Saab and Dudley 1998, Hejl and McFadzen 2000), and no studies have examined the nesting success of cavity nesters in logged versus unlogged burned forests (Kotliar et al. 2002). Understanding the reproductive success of cavity-nesting birds is important to determine whether the conditions created through logging in fact mimic the natural succession of post-fire forests providing the necessary conditions for successful breeding (Hutto and Young 1999; Kotliar et al. 2002). Focusing on the study of the nesting success of cavity-nesting birds in burned logged and unlogged forests established the scientific relevancy of the Bitterroot CBM project.

Furthermore, the visibility, abundance, and ability to survey many groups at one time make landbirds good indicators of how land management affects wildlife (Hutto and Young 1999). Birds are relatively conspicuous announcing their presence through vocalizations (e.g. song) or mechanical means such as timber drilling by woodpeckers (Hutto and Young 1999). Narrowing the study to focus on the 21 species of cavity-nesting birds (see Appendix B) typical in western Montana coniferous forests also simplified the data collection process for volunteers with limited bird identification skill.

It was also assumed that the significant interest, by Audubon members in observing birds in the Bitterroot and Missoula vallies offered a source of potential volunteers with some level of skill in identifying and observing birds. Birders like those found in Audubon membership are familiar with volunteer-based bird monitoring programs through participation in a variety of local, national, and international 'citizen science' projects such as the Breeding Bird Survey and Christmas Bird Counts. Citizen science projects attempt to capture the interests and talents of dedicated birders to gather data on bird populations for use by researchers to develop conservation priorities and strategies. The Bitterroot CBM project with its focus on bird monitoring was developed with a similar interest in mind.

And finally, scientific agencies often do not have the resources or provide the support for ecological monitoring programs. Wildlife populations are typically dispersed over a large landscape that makes it difficult to gather the information needed to understand population trends.

Public participation theory and the needs of science and the public to understand the ecological dimensions to disputes over post-fire land management activities guided the development of methods for the volunteer and monitoring programs. Particular emphasis was placed on recruiting participants with diverse viewpoints and to establish scientifically rigorous methods contributing to the credibility of data gathered.

Methods

The Bitterroot CBM project has two distinct components, a volunteer component and a field research component. Each component is relevant to the other however each required different methods. For example the methods for recruiting and retaining volunteers are very different to the methods for conducting the field research. Therefore, discussion of the methods associated with the volunteer program is followed by a discussion of the methods for the field research program.

Volunteer Program

Program design.

To implement a CBM program requires a balance between the need to gather credible data and the needs of participants. The desire to overcome issues of scientific credibility helped give shape to methods for building a volunteer program. T his project adopted the following recommendations (Whitelaw 1999):

1. Report back to volunteers to keep interest up
2. Officially recognize volunteer work
3. Present a clear vision and goals for the program
4. Use anecdotal information
5. Assess monitoring skill and tailor monitoring appropriately
6. Apply professional rigor in terms of scientific standards and design to volunteer monitoring. This does not mean that protocols cannot be simplified but does mean that monitoring must be based on proven techniques.
7. Verify data

8. Set standards for quality control

9. Use large sample size where possible

10. Use volunteers to undertake reconnaissance monitoring.

The volunteer program included four components, each with its own set of methods: volunteer recruitment, training, in-season volunteer development, volunteer retention and assessment. The design at all levels was guided by the principles of inclusiveness – engaging a large and diverse audience - providing quality training and outreach to meet needs of science and education, and developing a base of social capital to meet future monitoring needs.

Recruitment.

The purpose of the recruitment program was to inform a large and diverse audience about the opportunity to participate in the CBM program. Targeted audiences included Audubon chapters, watershed groups, agency personnel, and the environmental community as well as the public at large including landowners, educators, and University and high school students. Recruitment methods included use of public service announcements (PSA) to local media, distributing flyers throughout the Missoula/Bitterroot Valleys (see Appendix A), public presentations to community groups such as Audubon chapter meetings, and circulating announcements via the Internet utilizing a network of environmental education, NGO's and government partners. Recruitment continued throughout the field season. These recruitment methods were used in both the 2003 and 2004 field seasons.

Training.

The purpose of the training program was to develop a core group of volunteers with a base level of skill to successfully follow nest searching, monitoring, and data gathering protocols. Thus, the training program was an important component for meeting data credibility and participant education objectives. Volunteers and paid staff participated in 16 - 24 hours of training over a two-week period. Training was a combination of classroom (two weekday evening sessions) and field programs (all-day weekends). Given the disparate skill levels, training focused on skills development for accurate bird identification, efficient nest searching procedures, and interpreting bird behavior to identify nesting stages. Additional focus was on ensuring participants understood and followed appropriate, standardized data collection protocols. This included how to accurately and consistently record observations in field nest data cards. Topics also included how to use field research equipment (compass, GPS, cavity-peeper camera, binoculars), safety in the field, monitoring schedules, and communication. A field methods manual helped with both the training and for use in the field (see Appendix C).

Volunteers recruited after the training program were assessed by the project coordinator for skill level and then scheduled with the appropriate field coordinator. Field coordinators were given instructions to train the volunteer in the field and to assess skill development as the season progressed.

Scheduling and Implementation.

Martin (1993) and Saab (2003) recommend that nests are monitored every 2-3 days to estimate fledge dates. This requires a substantial amount of time in the field from the beginning of the nesting season in early May through August. Following this protocol was important to meet the data reliability objective of the CBM project. It was not feasible to expect a large number of volunteers to meet the demands of the monitoring. Thus, it was necessary to have field coordinators – dedicated, skilled, volunteers or staff - committed to a regular survey schedule. In 2003, 4 volunteers were compensated for travel in return for committing as field coordinators. In 2004, field coordinators were hired as Audubon staff and compensated for travel. Each field coordinator was assigned one research plot to survey three days per week and no surveys were conducted without the presence of a field coordinator or staff.

To avoid competition for use of the limited field equipment and to give ample opportunity for volunteers to participate during the week and on weekends, a monitoring schedule was developed at the conclusion of the training that established when and which research plots would be surveyed throughout the season. The two research plots within each study site were close enough that, if needed, equipment could be shared and volunteers could choose to survey a logged or unlogged site. Each study site (Blodgett Fire or Upper Rye Creek) was surveyed 3 days a week alternating days of the week. No surveys were conducted on Thursdays. Once the field season started, it was the responsibility of the volunteer to communicate with the field coordinator to arrange meeting times and to make travel arrangements. Research equipment and supplies (extra nest cards, batteries, flagging, etc.) was kept in a central location (my garage in Corvallis).

Retention and Assessment.

Recommendations 1 – 5 and 10 from the program design section above relate to maintaining volunteer interest during the field season and over-time. Maintaining a high level of interest and enthusiasm for the goals of the CBM project addressed the issues of not only retention but also data accuracy. Communication with volunteers and the public at large about the CBM program, data collection results, and other interesting related subjects is an important component of meeting the retention objective. Throughout the 2004 field season, the project coordinator distributed emails to the volunteer network informing them of current successes and challenges. This included reporting the number of nests found to date, exciting finds or reports from volunteers and interns about events in the field, and news or events on subjects of forest fires, fire ecology, or relevant birds.

To acknowledge the work of volunteers, the local newspaper was invited to do a story on the project and work of community members. Furthermore, at the conclusion of the 2004 field season, the project coordinator hosted a potluck dinner to acknowledge volunteer work, to share stories from the field season, and to provide a preliminary summary of data collected. Simple gifts like t-shirts were given to each volunteer and special awards (bird feeders, field guides) were given to the volunteer who contributed the most hours and for the volunteer who found the most nests as a way to show appreciation for volunteer efforts. In subsequent months, volunteers were periodically given updated data summaries, reports on the efforts to protect post-fire landscapes, and information about community forest and fire management public presentations or news items.

Volunteer assessment provided feedback on the strengths and weaknesses of the program, established a volunteer profile, and documented some of the qualitative benefits of the project. Questionnaires were distributed to participants at the end of the field season. The 2003 questionnaire attempted to assess overall participant satisfaction with their involvement in the CBM program and feedback for improving the program for next year. Questionnaires in 2004 were structured to provide a participant profile assessing prior knowledge of forest management, individual forest use/participation, fire ecology knowledge, communication networks, and environmental values as well as to provide feedback on their participation.

Cavity-nesting Bird Monitoring

Study Sites.

Uniformity across fire severity, post-fire management, and forest community was central to the selection of study sites. Like most forest fires, the fires of 2000 burned with a variety of intensities creating a mosaic of patterns across the landscape. Twenty-nine percent (122,400 acres) of the more than 300,000 acres that burned in 2000 on the BNF was in roaded land. Of that, only 9% (36,400 acres) burned at a high severity or (80-100% crown removal), and 6% (24,400 acres) moderate to mixed intensity (20-80% crown removal, and 14% (59,500 acres) at low intensity or 1-20% crown removal (Bitterroot National Forest 2000). Study site selection was focused on high-severity burns; however, there was a mix of burn severities on each study site. Within each study site, logged and unlogged replicate research plots were established. Logged sites varied in logging intensity from severe (less than 2 snags per acre) to partial (more than 5-8 snags per acre). Based upon conversations with BNF sales administrators, both logged research plots exceeded the prescribed snag retention rates. Also, stream management protection zones of 100 ft to 200 ft created even more variability between both logged research plots. Despite the considerable variability across both logged and unlogged sites, no methods were established to measure the snag density or other vegetative characteristics of each research plot.

Anticipating the need to have research plots be accessible to a wide range of volunteer physical abilities, and in an attempt to simplify the boundaries of the research plots, each research plot used a road as a transect and nest searching was limited to 100 ft on either side of the road. Therefore, the research plots were defined by the length of the road (i.e. the transect) and 100 ft on either side of the road. Detailed descriptions of each research plot are below. When possible, study sites would overlap with studies focusing on similar burned forest bird research coordinated out of the University of Montana Avian Science Center.

The Blodgett study site burned 4,047 ha (10,000 acres) in 2000. This fire forced the evacuation of 900 homes (Bitterroot National Forest, 2000) and at one time was the highest priority fire in the nation. Within the Blodgett Fire study site, was a 44 ha (109 acres) partially logged research plot, and an unlogged 33 ha (82 acres) research plot (see Map 1).

The partially logged research plot elevation ranged from 1,323 m (4,340 ft) to 1,414 m (4,640 ft). Pre-fire conditions were primarily even-aged stand of ponderosa pine and Douglas fir. Logging occurred at two different times post-fire. The first salvage was during the winter of 2001 on a small (10-20 acre) "demonstration/wildlife cut." The second cut encompassed the entire research plot and occurred during the winter of 2002. Snag size retention rates within the cutting units was 10-17.9" = 4 trees/acre, 15-19.9" = 1 tree/acre, and one 20-24.9" tree/acre. No logging occurred within 200 feet of streams.

Snag retention rate was exceeded across the entire study site due, in part, to the removal of higher valued Douglas fir trees leaving numerous standing dead ponderosa pines (Bitterroot National Forest staff pers. conv.).

The unlogged research plot within the Blodgett fire study site started at the end of the partially logged research plot. Elevation range of the unlogged research plot was 1,414 m (4,640 ft) and climbed to 1,823 m (5,980 ft). Characteristics of this site included mostly steeper slopes, more south facing aspects and thus a more open canopy than the logged plot. Like the logged plot, tree species composition is mostly ponderosa pine and Douglas fir.

The upper Rye Creek study site is within the Skalkaho/Rye fire complex that burned in August of 2000. Two replicate severely logged and unlogged research plots were established.

The severely logged research plot was 56 ha (139 acres), with an elevation range of 1,585 m (5,200 ft) to 1,719 m (5,640 ft). This site was heavily logged over successive years pre-fire and then again logged after the fires. Snag size and retention rates included 10-17.9" = 1-2 trees/acre and 18.0"+ = 1 tree/acre. Snag retention rate was exceeded throughout the research plot yet the number of snags per acre was obviously considerably lower than the partially logged plot on the Blodgett fire study site. This research plot is considered a vegetation response unit 2 - ponderosa pine early seral and Douglas fir late seral (Bitterroot National Forest staff pers. conv.). There was no logging within 100 ft of stream corridors (see Map 2).

The unlogged research plot was 41 ha (102 acres), with an elevation range of 1,451 m (4,760 ft) to 1,585 m (5,200 ft). The north side of this research plot was mostly open ponderosa pine south facing aspect and the south side of the research plot was mixed conifer, closed canopy, north facing aspect. This transect was mostly high severity burn.

All four research plots used a road for the transect route, was accessible throughout the field season and of moderate to low slope.

Nest Searching.

We searched for nests of the common species of cavity-nesting birds in coniferous forests of interior western Montana (see Appendix B) following nest searching and monitoring methods described for BBIRD, Breeding Bird Research and Monitoring Database (Martin 1993, Ralph 1993) with some modifications. Nest searching methods attempted to find every nest within 100 ft of either side of the research plot transect (i.e. road). The date nest searching began varied from 2003 to 2004. In 2003, nest searching began on 29 June. In 2004, nest searching began on 9 May. According to Hitchcox (1996), the most active period for finding nests is in early to late June. Systematic bird surveys concluded on 13 July in 2003 and 27 July in 2004 although in 2004 a few nests were monitored until mid-August.

Field observers were in position to begin their nest searching 15 min after sunrise, which is usually between 0515 and 0545, Mountain Standard Time. Thus, nest searching began after the pre-dawn chorus and continued throughout the period during which bird activity and song is relatively constant. Nest monitoring (revisiting nests already found) began after 1100 Mountain Time when the majority of birds have quit singing and efficiency of finding new nests declines. Saab and Dudley (2003) recommend ending nest surveys by 1200 each day however the summer of 2004 was relatively cool so we collected data until 1400 if birds were still active.

Later in the season (mid-to late June) when most birds had already established nests and begun to brood eggs or feed young, nest searching began one hour after sunrise. Nest monitoring began at the same time as observers moved through the research plot.

Nest searching and monitoring was canceled when the weather was bad enough to influence bird activity – that included continuous rain (but not light drizzle) and wind that was constant and of enough strength to bend the tops of trees (4 on the Beaufort wind Scale). The weather across the Northern Region is so variable that field observers traveled to the plot before assessing weather conditions. If after 1 to 1.5 hours of steady rain or wind or until it was not reasonable to complete the nest searching or monitoring by 1300, then the transect was not surveyed.

Nests were found by locating birds by sight or sound and following the birds to a cavity. Volunteers were instructed to develop a search image or "gestalt" for possible-nesting trees based upon Saab and Dudley (2003) recommendations for likely nest tree characteristics (e.g. nest near top of broken top trees where wood is softest). Once a new nest was found, it was given a number in the order it was found, nest location was described through a hand drawn map on a new nest card, and a written description using compass bearing, and pacing from a transect point or an obvious landmark. Transect points were marked by red flagging placed along the road (i.e. road) at 50 m intervals. If necessary, flagging was used to mark a nest observation point that was more than 20 meters from the nesting tree (further in open forests). Global Positioning System was used to record nest location and coded using the research plot code followed by the nest number in order that it was found.

Nest Monitoring and Fate.

Once a nest was found, it was monitored every 2-3 days (or every day a survey was conducted) up to fledging. Nesting stage (e.g. excavation, incubation, nestlings, fledge) was determined through observing bird behavior or by viewing nest contents with a camera mounted at the end of a 30 ft telescoping pole. Care was taken to limit disturbance of nest and the camera was not used unless it was certain that birds were committed to the nest (i.e. incubating or hatchlings). Nest fate was determined by tracking nesting stages to estimate fledging dates and then careful observation of fledglings at nest cavity or near nest post-fledging. If nest mortality occurred, the nest tree was searched to determine cause (i.e. weather, predator, other). Nest cards were filled out each day the nest was visited. At the end of each field day, the field coordinator was required to transfer data from nest cards used in the field to a duplicate set of nest cards for two reasons: to make sure there was always a current back-up set of nest cards and to capture any inconsistencies in the data recorded by volunteers. Once a nest was complete (failed or fledged), nest tree species, DBH, height and nest height were recorded.

Results

Like the methods above, the results are divided into two sections, results from the volunteer program and results from the field research/data collection.

Volunteer Program

Volunteers were informed about the CBM project most commonly through 'word of mouth'. However, announcements in Audubon newsletters, PSAs in local media, and flyers were also documented as sources of information. In 2003 and 2004, a total of 36 people attended the information meeting held on an early weekday evening. The audience represented a diverse background of Bitterroot and Missoula valley residents: a rancher, an elementary school teacher, several Audubon members, two University of Montana graduate students, a high school student, and another mother-daughter team (the daughter was a junior in high school).

Of the 36 participants that attended the information meeting, half completed the pre-field season training. The number of hours trained was between 16-24 hours over a ten-day to two-week period. Trainings were held on weekday evenings and both weekend days.

The 2003 field season started on 29 June when most birds are entering a more discrete nesting period of incubation and nestlings which, significantly compromised nest finding efforts. The 2004 field season began on 9 May. In 2004, volunteers participated in 16 of the 27 days of bird surveys (60%). Over both field seasons, 30 volunteers contributed over 600 hours to the study and assisted with finding 96 nests for 11 species of birds. Including cavities that birds occupied but did not commit to (i.e. egg-laying stage), we found 135 nests.

Following both the 2003 and 2004 field seasons, participants were asked to complete an evaluation/questionnaire. Five of the eight volunteers who participated in 2003 returned evaluations. Participants rated the overall citizen science experience and quality of the training on a scale of 1 (fair) to 5 (excellent). Overall experience was given a 4 and the training a 3.1. When asked to provide suggestions to improve the training, each volunteer made reference to more preparation on bird identification and bird nesting behavior. When asked if they would participate in another CBM project 4 of the 5 evaluations responded with a resounding "definitely" and one dissenting maybe. Volunteers commented that their interest in participating in another CBM project included:

- "good company, pretty countryside",
- "I met people who were able to show me new birds so I learned a lot",
- "I enjoyed working with non-biologists and community members",
- "I learned that I can teach other people (how) to identify birds, I met people, it got me up in the mountains at the prettiest time of day".

Others commented on the gratification of learning and sharing their knowledge about birds and ecology with others. Suggestions from the 2003 volunteers for improving the program tended to focus on the need to get more volunteers involved and to definitely start the season earlier.

After the 2004 field season, 9 of the 15 volunteer questionnaires were returned. Questionnaires in 2004 were structured to provide a participant profile assessing prior knowledge of forest management, individual forest use/participation, fire ecology knowledge, communication networks, and environmental values as well as to provide feedback on overall quality of the participant experience. Providing some insight on participant environmental values, 66% of responses felt that the most important function of National Forest lands was to sustain healthy wildlife population. And all responded that the top management priority on national forest lands is ecosystem health over managing for timber resources, recreation, wilderness, and wildlife. A majority (89%) believed that forests do need to be managed.

Seventy-eight percent of responses frequently visit the National Forests, while 22% visit on occasion. The most common use of the National Forests was to watch wildlife, hike/camp, nature walks, skiing, mountain biking, and hunting/fishing. No participant cited use of National Forest lands through mechanized travel (snowmobiles and OHV).

Newsletters and magazines were the most often cited source of information about forest fires and their effects on forest health followed closely by newspapers. All but one participant had at one time or more written letters to newspapers or public officials addressing issues related National Forest management. Seven of eight volunteer responses indicated that knowledge gained through participation in the bird surveys proved to be useful when engaging in discussions about forest management and/or fire ecology with others outside the CBM program. In addition, volunteers regularly communicated about the CBM program and related subjects of birds, fire ecology, wildlife, and forest management with others such as family, friends, colleagues at work, or chance encounters with people on the street. The most common discussions occurred with families followed by discussions at work and casual encounters with the public respectively.

Assessment of their participation in the monitoring program and the program itself provided useful information for future development of the program. Volunteer responses indicated that there is room for improvement particularly in relation to the training. However, overall satisfaction was high (see Table 3). And each participant indicated achieving a higher level of birding skill (see Figure 1). When asked if willing to participate in another CBM program, 71% (n = 5) responded with a definitive yes and 21% (n = 2) with a maybe.

Table 3 -- Percent of volunteers rating the overall quality of experience as participants in the CBM Program and quality of the training program.

	Poor 1	2	Good 3	4	Excellent 5
Rate your experience				37%	63%
Quality of the Training Program			12%	50%	37%

Figure 1 -- Percentage of volunteers reporting an increase in birding skill based upon self-assessment before and after participating in the CBM project. Scale of 1 (poor) to 5 (excellent).

Many volunteers commented that practicing the skills required for effective field research such as patience, deliberate observations, and time outside created some of their most memorable experiences. In conversations with volunteers, many noted the enjoyment and knowledge gained from spending time in the field with the field coordinators/staff. Volunteers also commented on the benefits they felt from contributing to a "worthwhile" effort that had some potential conservation benefit to birds. Recommended changes from 2004 to apply to the 2005 field season included providing bird behavior and identification fact sheets that could help interpret bird behavior for use in the field and to provide maps of the study site to help interns and volunteers orient themselves to the study area and to grasp the distribution and location of nests.

In summary, volunteers who responded to the questionnaire tended to be active, low-impact outdoor recreationists, willing to support management practices on national forests that maintain ecosystem health, and empowered to voice their knowledge and experiences with the public and others through formal (i.e. letters to the editor) and informal (i.e. social conversations) communications. Volunteers gathered their information about forest management and fire from media, magazines, newsletters, and the Internet.

Bird Monitoring Data

Data from the 2003 field season are not included in this section due to the fact that funding restrictions prevented the ability to start the field season until 29 June and thus we found only 8 nests. This data was considered insufficient for the purposes of this project. Of the 41 possible field days in 2004, each research plot was surveyed 27 days. A total of 88 nests of 11 bird species were found. Including cavities that birds occupied but did not commit to (i.e. eggs were not laid), number of nests found was 127. Nesting stage (e.g. excavation, incubation, nestlings, fledge) was determined through observing bird behavior (52%) or by viewing nest contents with a camera (48%). The partially logged site (Cow Creek lower) had 8 species of birds. The severely logged site (Little Bull) had 7 species, and unlogged sites (RD 311 and Cow Creek upper) each had 7 species (Table 4).

The four most abundant species with nine or more nests were House Wren, Mountain Bluebird, Northern Flicker, and Lewis's Woodpecker (see Table 4). Each species is considered typically more abundant in burned areas versus unburned areas (Kotliar et al 2002). Williamson's Sapsucker is the only species that is typically neutral in its response to burns and this nest was found off-plot in a low-severity portion of the study site in a relic snag. None of the remaining species besides the one (failed) Three-toed Woodpecker are typically more common in burned areas versus unburned areas (Kotliar et al 2002).

Of the 88 nests found, there were almost twice as many nests in the logged sites versus unlogged sites (see Table 4) with the partially logged research plot having the most nests (n = 32) and the unlogged plot in the Blodgett Study site having the fewest number of nests (n = 12). The partially logged plot had .73 nests/ha, the severely salvaged plot had .48 nests/ha and together, the unlogged sites averaged .39 nests/ha. (Maps 3 - 6 in the Appendix display nest dispersal for each research plot.)

Table 4 -- Number of cavity-nesting bird nests found in partially logged, severely logged, and unlogged plots in southwest Montana, 2004. Number of nests/ha for each research plot (acres in paranthesis).

			Unlogged		
	Partially Logged	Severely Logged	Cow Creek upper	RD 311	**Total**
House wren	10	4	4	7	25
Mountain bluebird	0	11	3	4	18
Northern Flicker	3	6	1	2	12

Lewis's woodpecker	8	0	1	0	9
Hairy woodpecker	3	2	0	1	6
Western bluebird	2	1	1	1	5
American kestrel	3	2	0	0	5
Red-breasted nuthatch	1	1	1	1	4
European starling	2	0	0	0	2
Williamson sapsucker	0	0	0	1	1
Three-toed woodpecker	0	0	1	0	1
Total	**32**	**27**	**12**	**17**	88
Nests per hectare	**.73 (.29)**	**.48 (.19)**	**.36 (.15)**	**.41 (.17)**	

Frequency of nest selection was put into three groups following a similar process to Hejl and McFadzen (2000): species with nests mostly in unlogged plots, species with nests divided equally in all three plots and, species with nests mostly in the logged plots. No species was more common in the unlogged plots whereas Lewis's Woodpecker, American Kestrel, Northern Flicker, Mountain Bluebird, Hairy Woodpecker, and to some extent House Wren nests, were mostly in the logged plots. Of these species, Lewis's Woodpecker and House Wren nests were mostly in the partially logged plot and Mountain Bluebird and Northern Flicker nests mostly in the severely logged plot. No species had nests mostly in the unlogged plots.

According to the BBIRD protocols, 20 nests are needed for nesting success data to be considered reliable (Hensler and Nichols, 1981 cited in BBIRD, 1997). House Wren was the only species with 20 or more nests (n = 25). Nest success rate for all species was highest (81%) in the partially logged plot (Table 5). Overall nest success rate in the severely logged site was 59% (n = 27) and the unlogged site was 69% (n = 29). Mountain Bluebird had the lowest success rate of all species. There was little difference in nesting success rate for Mountain Bluebird's in the unlogged (43%) and severely logged (45%) research plots. Of all species nesting in the partially logged plot, Lewis's Woodpecker had the lowest success rate of 75% losing 2 out of 8 nests. House Wren nest success of 91% was equal in the unlogged (n = 11) and partially logged plots (n = 10) and only 50% in the severely logged plot (n = 4).

Table 5 -- Percent nesting success for all cavity-nesting species in partially logged, severely logged, and unlogged plots. Number of nests in parentheses.

	Partially logged	Severely logged	Unlogged
American Kestrel	100 (2)	100 (2)	
European Starling	100 (2)		
Hairy Woodpecker	100 (3)	100 (2)	100 (1)
House Wren	91 (11)	50 (4)	91 (11)
Lewis's Woodpecker	75 (8)		100 (1)
Mountain Bluebird		45 (11)	43 (7)
Northern Flicker	100 (3)	67 (6)	67 (3)
Red-breasted Nuthatch	100 (1)	100 (1)	50 (2)
Three-toed Woodpecker			0 (1)
Western Bluebird	100 (2)	0 (1)	50 (2)
Williamson's Sapsucker			0 (1)
Total	**81 (32)**	**59 (27)**	**69 (29)**

Twenty-four percent of all nests failed. Of these, 43% were caused by predation with the remaining due to weather or unknown. Black Bear (*Ursus americanus*) predation was noted on at least one Northern Flicker nest. A House Wren was observed removing nest material from a Mountain Bluebird nest. Subsequent searching at the base of the nesting tree found several Mountain Bluebird egg fragments. A Pine Squirrel (*Tamiasciurus hudsonicus*) was directly observed entering a Northern Flicker nest with known nestlings. Observation with the camera revealed a dead female Northern Flicker yet no fur, bones or other signs of nest predation were present around the base of the tree. Common Raven was regularly observed flying through the partially logged site. At one point, a raven was seen flying through the partially logged site with a white egg in its bill. American Kestrel nests on both logged sites were in close proximity to Lewis's Woodpecker, Mountain and Western Bluebird nests. One volunteer watched a female American Kestrel remove a dead Kestrel chick from a nest on the partially logged plot.

Discussion

Understanding how to design and implement a CBM project began with identifying an issue of common community concern that reflected the multiple dimension of natural resource issues and the information needs of science and land managers relevant to that issue. The issue of fire was a useful tool for testing the Bitterroot CBM project because of its prominence in management, the significant public interest, and its symmetry with the patterns of many natural resource disputes. Based upon the results of the Bitterroot CBM project, the discussion that follows will address the questions posed in the introduction.

First, is there value beyond the benefits to individual participants that a CBM project can contribute to understanding and resolving natural resource disputes? The attempt to recruit a diversity of people representing different viewpoints about fire, wildlife, and post-fire land management activities is directly related to attempting to answer this question. Recognizing the social complexities of the issue of post-fire landscape management and the increasing scientific evidence of the ecological role of fires in maintaining healthy forest ecosystems, it was believed that participation in the process of gathering science-based information relevant to the issue would help bridge these two competing interests. In turn, this would raise awareness and understanding of the multiple dimensions of post-fire landscape management and provide for participants objective science-based interpretations of the dispute.

The increase in number of people who participated in the program from 2003 to 2004 (8 participants in 2003, and 21 participants in 2004), suggested that recruitment methods were effective at informing the community about the project and getting people involved. Yet, despite the fact that participants included a diversity of people representing different elements of communities in the Bitterroot valley (a postal worker, a rancher, teacher, school administrator, high school students, and local retiree's), results from the volunteer questionnaire and through personal observations suggested that, participants had interests similar to the project implementers (i.e. Audubon). Participants had an interest in birds, were generally well-educated gathering information about forest fires and post-fire landscape management activities from multiple sources, and shared similar views about the priorities of land management (i.e. ecosystem health). Based upon these results, the Bitterroot CBM project did not meet the objective to recruit a diverse audience representing a diversity of viewpoints and thus brings into question the utility of the Bitterroot CBM project as an effective strategy for resolving natural resource disputes. However, this does not suggest that all CBM efforts are not of value.

Bliss et al (2001) suggest that for ecological monitoring programs to succeed at helping shape and guide land management, and thus realize the benefits of public participation, it is critical to engage multiple stakeholders early in the design of the monitoring program. The monitoring program design, which includes the selection of indicators and the purpose of the monitoring, will then more accurately reflect the multiple social and ecological dimensions of the natural resource issue. As mentioned in the literature review, Pollack (2003) identified four examples of community ecological monitoring programs, including multi-party monitoring programs that attempt to address issues of governance through achieving high levels of inclusiveness – a central component of public participation theory. Also identified by Pollack (2003) are CBM programs that attempt to promote a particular interest or issue – an advocacy program.

Given that the Bitterroot CBM project did not achieve a high level of inclusiveness in the design and implementation of the monitoring program, this project more accurately reflected the definition of an advocacy program and not a multi-party effort. The inability to recruit multiple viewpoints into the monitoring program also supports the suggestion introduced by Arnstein (Stadel and Nelson 1995) that realizing the benefits of public participation is determined by the level of inclusiveness a public participation strategy adopts.

If the Bitterroot CBM project is to evolve into a strategy for resolving natural resource disputes like post-fire landscape management, then it will need to be more inclusive in identifying the purpose and objectives of the monitoring program. A first step will be to build partnerships with a diversity of stakeholders such as the Forest Service, economic interests such as timber, recreation, and local businesses, and others such as the environmental community and private landowners and include these interests more completely in the design and implementation of the monitoring program.

The purpose for identifying scientifically rigorous methods that meet the anticipated abilities of volunteers was directly related to answering another question presented at the beginning of this study - can CBM projects overcome issues of scientific accuracy to become a resource for science and land managers to fulfill ecosystem-monitoring needs? In answering this question, I make the distinction between data quality and data credibility. Data quality is the confidence that volunteers followed scientifically valid methods and gathered data accurately according to these protocols. Data credibility is the scientific validity of the study volunteers participated in and thus the relevance or credibility of the data for use in scientific understanding of the nesting success of cavity-nesting birds in burned logged and unlogged habitats.

The Bitterroot CBM training program, identification of appropriate methods, and quality control mechanisms were instituted to address the issue of data quality. Despite the fact that volunteers were encouraged to attend 18-24 hours of pre field season training, learning the methods associated with finding and monitoring nests was just as easily taught in the field versus in the classroom. This is due, in part, to the fact that there are only 21 cavity-nesting bird species in western Montana and cavity-nesting birds are typically more visible than inconspicuous songbirds. Thus volunteers with little birding experience could quickly become competent in locating and identifying target species, which significantly enhances their contribution to one of the primary objectives of the monitoring program - finding nests. Often, while searching for nests there are multiple target bird species within sight and having more than one person in the field to track more than one bird at a time significantly helped with efficiency in nest searching and monitoring. This led to my increased confidence that a majority of nests were found on each of the research plots. However, it can be argued that nest-searching effort across each of the research plots was not equal due to the fact that the number of standing dead trees varied from plot to plot. Thus, it is likely that plots with more standing trees would have required more effort to find all cavity-nesting bird nests. Without measuring nest searching effort, data collected through the Bitterroot CBM project can be viewed with skepticism.

In addition to identifying appropriate methods, having qualified, skilled staff in the field with volunteers offered a level of quality control when volunteers either found nests or they were monitoring the progress of existing nests found. After volunteers entered their observations on the nests cards (i.e. field data forms), staff reviewed the nest cards in order to identify any inconsistencies or unusual observations.

The increase in number of nests found from 2003 to 2004 (8 nests and 5 species of birds in 2003; 88 nests for 11 species of birds in 2004) was directly related to the fact that the field season in 2004 began on 9 May during a time when birds are more conspicuous. In 2003, the field season started on 29 June when birds are entering a more discrete period of the breeding season. Volunteers should be acknowledged for helping reach these totals given the fact that they participated in the bird surveys 60% of the field days. The results of the Bitterroot CBM project suggest that with limited training community volunteers do have the capacity to gather quality data and to follow scientifically appropriate methodology, however the issue of data credibility remained in question.

Perhaps the most significant factor that influenced the credibility of the data is not who collected the data but rather the design of the study and selection of study sites. Even with the increase number of nests found in 2004, this study did not find the suggested number of nests per species for effective analysis. According to BBIRD protocols, 20 nests are needed for nesting success data to be considered reliable (Hensler 1981). There was only one species (House Wren) that had the required number of 20 or more nests. This suggests that possibly the study sites were not large enough. Similar studies on the response of cavity-nesters to post-fire salvage logging have larger study areas. Saab et al (2000) surveyed on average a total of 1,852 ha per year across two study sites, and Hitchcox (1998 unpublished) surveyed a total of 128 ha of unlogged sites and

134 ha of logged sites. Saab and Dudley (2003) recommend that study units be 250-400 ha in order to obtain a large enough sample size for estimating response to habitat changes. Furthermore, there was considerable variation in density, size class, and distribution of standing dead trees between logged and unlogged plots. Without a larger sample size, it is not possible to rule out variations in site forest structure, logging prescriptions, elevation and other intangibles as a cause for differences in number of nests, diversity of species, or nesting success per research plot or species. Although it is possible for volunteers to follow scientifically valid methodology, the complexities of conducting field research may preclude the ability of a purely volunteer based study to gather data relevant to the needs of science.

Even without statistical analysis, a comparative analysis with data results from similar studies revealed some interesting patterns. For example, this study found twice as many nests of cavity-nesting birds in the two logged plots (n = 59) versus the unlogged plots (n = 29). Hitchcox (1998) reports the opposite with three times more nests in unlogged sites versus logged sites. The diversity of cavity-nesting bird species found per management prescription in the Bitterroot CBM study is consistent with the number found in Saab and Dudley (1998). Saab and Dudley (1998) reported 9 species on partially logged (wildlife salvage) and unlogged plots whereas this study reported 8 and 7 species respectfully.

Three of the four bird species with the most nests monitored in this study were Northern Flicker (n = 12), Mountain Bluebird (n = 18), and Lewis's Woodpecker (n = 9). Nest success rates for these species was 75%, 47%, and 78% respectfully. Despite significant differences in number of nests monitored, Saab and Dudley (1998) reported similar nest success rates for the same species - Northern Flicker 79% (n = 97), Mountain Bluebird 51% (n = 96), and Lewis's Woodpecker 81% (n = 206).

Arguably, the relevancy to science of these patterns is diminished without statistical analysis. Yet as mentioned above, given the high confidence that volunteers and staff followed appropriate field methods, questions of data credibility are possibly more related to flawed study design and lack of expert (i.e. professional scientists) oversight during the design and implementation of the monitoring program than the ability of volunteers to gather quality data. This raises the question that does a focus on product (i.e. credible data) with more direct oversight and project development by experts (versus multiple parties) restrict public participation or level of inclusiveness, and thus diminish the benefits from participating in the full process of science inquiry? As experienced in 2003 when volunteers did not feel successful in gathering quality data, would changes to address data credibility affect the positive social and educational outcomes realized by participant?

Without attaining a degree of data credibility, it can be argued that a CBM program is better suited to create exceptional learning opportunities that raise awareness and understanding of the ecological dimensions of natural resource disputes versus achieving goals in scientific research. What also remains in question is whether or not relevancy - the notion that efforts of the volunteers meaningfully contributes to science or land management – affects the commitment of volunteers to follow the appropriate monitoring protocols. For, as discussed below, many of the most profound learning and social benefits volunteers realized through participation in the Bitterroot CBM project were related to practicing the skills necessary for gathering quality data.

Perhaps the most significant impact of the Bitterroot CBM program was related to answering the third and final question of this study, are CBM projects an effective tool for increasing public awareness and understanding of the multiple dimensions of natural resource disputes and if so, what are the benefits to participants in the Bitterroot CBM project? Despite the fact that participants shared similar views about land management and shared a similar interest in observing bird/wildlife, and outdoor recreation, the results of this study suggest that CBM projects provide a quality and effective educational experience. Participants enjoyed the experience for as much if not more the social and personal learning opportunities as the conservation context or science inquiry purposes of the CBM program. Yet, when asked to describe their most memorable experiences or why they would participate in future CBM programs, volunteers routinely described experiences that were directly related to practicing good field research skills – deliberate observations, sensory awareness, patience, frequent time outside - as key factors in their positive assessment of the Bitterroot CBM project. It can be argued then, that the attention to following scientifically rigorous methods and the insistence on gathering credible data are relevant to the social/educational benefits realized by volunteers such as; intimate encounters with wildlife, observing unusual and interesting bird behaviors, improved birding skills, spending time outside learning from others, observing wildlife, and witnessing post-fir forest succession through the seasons. In addition, volunteers acknowledged that through participation in the Bitterroot CBM project they developed a deeper understanding of the ecology, beauty, and diversity of life represented in burned forests, a deeper awareness and understanding of birds, fire ecology, and post-fire forest succession, a willingness to share knowledge gained with family, friends, and colleagues, and a willingness to continue participating in future CBM projects. These results indicate that the Bitterroot CBM project did raise awareness and understanding of the ecological dimensions of post-fire landscape management and of science inquiry while also building in participants a more personal connection place.

However, without a more thorough assessment of volunteer's prior knowledge and values it is impossible to quantitatively deduct the impact of the CBM program on participant environmental literacy – a critical pre-requisite to developing a conservation ethic (Disinger and Roth 1992). Yet, environmental education theory states that building environmental literacy is based on attending to both the affective and cognitive domains of learners (Disinger and Roth 1992). It is believed that participants in the Bitterroot CBM project, the 2004 field season in particular, were immersed in a learning environment and process that attended to both of these domains. The observable outcomes as described above are critical to developing in individuals the ability to make more environmentally responsible private and public decisions (Disinger 1992, Roth 1992, Disinger and Monroe 1994).

In conclusion, the benefits of the Bitterroot CBM project to individual participants and to the process of understanding how to meaningfully engage individuals in relevant and valid ecological monitoring is offset by its limitations. Often the information needs of land managers are more immediate and therefore the time and effort required to implement a volunteer based monitoring program may not serve the needs of land managers. And as mentioned above it is questionable that the data gathered through this project is of any significant value to those it was intended to be useful for (i.e. science and land managers).

Despite the fact that there is no cookie cutter model for developing CBM programs that address the complexities of natural resource disputes, including the public in a part of the decision-making process such as information gathering offers an opportunity for the public to develop a deeper appreciation and understanding for scientific management principles as well as develop the knowledge and skills necessary for making more environmentally responsible public and private decisions. Few would argue that a more ecologically informed public and a public more aware of the multiple dimensions of natural resource disputes would not help communities and land managers struggling with complex management decisions. Yet, it remains a challenge to develop effective strategies that address the significant gap in public awareness and knowledge of natural resource issues and the ability to make more environmentally appropriate private and public decisions. Demonstrating the synergistic effect of bringing together the skills and ideas of education professionals with the compelling and relevant objectives of science to address issues of common community concern is something this project, to some degree accomplished. In doing so, it is my hope that both scientists and educators will look to the value and utility of engaging the public in ecological monitoring programs to meet complimentary objectives.

Recommendations

Based upon our success and challenges of the CBM program, I offer the following suggestions for the development of future CBM projects:

1. A detailed understanding of monitoring purpose, indicators, and field research methods is critical before embarking on a CBM project.
2. As others have suggested, if the CBM program attempts to be inclusiveness, then involvement of vested parties and individuals early in the identification of monitoring purpose, indicators, data collection, storage, and dissemination is recommended. Is the monitoring program attempting to engage a variety of interests or just one or two?
3. Implement CBM projects around an issue of common community concern. This provides the context for learning and also the relevance of the study.
4. Apply data quality control mechanisms through volunteer self-assessment as recommended by EMAN (1999) or through oversight provided by skilled staff as done in the Bitterroot CBM project.
5. Engage multiple parties including those who can use the information collected through the CBM program early in the design to make sure that results of monitoring are used. This is directly related to data credibility. Direct oversight by experts is highly recommended throughout the CBM development and implementation.
6. Recognize the time commitment limits of volunteers. This is relevant to both the training and implementation phases of a CBM project.

7. If attempting to be inclusive of all audiences, contact individuals or groups outside traditional networks of organizations and colleagues. This can be achieved through making presentations at meetings or recruiting the support of a local community leader.
8. Be clear on why inclusiveness is important. It may determine when it is necessary to engage those audiences.
9. Capitalize on the learning opportunity. Engagement is one of the most difficult obstacles to overcome in developing effective education programs. As one skilled educator said, if the learner is excited about rocks and rivers, then I want to wrap all other content goals around that subject. The natural world provides numerous opportunities for engagement and thus opportunities to introduce other relevant ecological, social, or political discussions around areas of mutual interest (i.e. the monitoring indicators). These types of meaningful, in-depth, hands-on learning opportunities if capitalized upon, will build a deeper and more meaningful appreciation and awareness of the multiple dimensions of natural resource disputes and affect the ability of individuals to think critically about the impacts of personal public decisions.
10. To capitalize on the learning opportunity provide other non-traditional opportunities for recording detailed observations such as photography, field journaling, nature sketching, and naturalist walks. This can be offered to show appreciation for volunteer involvement and enhance the learning opportunities.
11. Volunteer recognition is critical to meeting both research/monitoring and social capital objectives. Develop fun and respectful ways to acknowledge volunteer

contributions publicly. Communicate with volunteers throughout the year to report progress on conservation objectives and future volunteer opportunities.

12. Develop an interactive website to keep data records, report interesting sightings, and communicate with others.
13. Develop a long-term (3-5 year) funding mechanism. This is recommended by other CBM initiatives and is necessary to build the volunteer base and to allow for some trial and error.

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Appendix A. Locations for distribution of program announcements in the Bitterroot and Missoula Valley

FOR EVENT:

HAMILTON	
	Common Ground
	Hamilton Public Library
	Rocky Mountain Labs
	Art City
	River Bend Athletic Club
	Hamilton Museum
	Wild Oats Café—Bulletin board upstairs and downstairs
	Bitterroot Bistro
	Chapter One Books
	Paper Clip
	Bulletin Board on Main Street by Sgt Pepper Shoes
	Spice of Life
	Place to Ponder
	Sunelco
	Bitterroot Brewery
	Chamber of Commerce
	Fishaus Tackle
	Rainbow's End
	Hamilton USFS Supervisor's Office
	Garden City Seeds
	Corixa
	Safeway
	Bitterroot Grocery Emporium
	Sgt Pepper Shoes
	Bitterroot Ecological Awareness Resources (BEAR)
CORVALLIS	
	Corvallis USPS
	Corvallis Conoco Mercantile
	Ravalli County Bank
	Woodside Store
VICTOR	
	Hamilton Pub
	Cantina La Cocina
	Victor Mercantile
DARBY	
	People's Market
	Darby Community Center
	USFS – District Office
CONNOR/SULA	
	Connor and Sula Stores
	Rocky Knob
	Outpost
	USFS – Sula Ranger District

STEVENSVILLE	
	Bi-Lo Groceries
	Bitterroot Star
	North Valley Library
	The Olde Coffee Mill
	Lee Metcalf National Wildlife Refuge offices
	USFS—Stevensville Ranger District
	Kodiak Jaks Restaurant
FLORENCE	
	Gary and Leo's Foods
MISSOULA	
	Brown Bear Resources
	Fact and Fiction
	Moose Cr. Mercantile
	Hob Knob
	Zimorino's
	Bernice's
	Butterfly Herbs
	The Trailhead
	Worden's Market
	Birdwatcher's Country Store
	Missoula Public Library
	Art Museum
	USPS
	Solar Plexus
	Clark Fork Coalition
	Grizzly Hackle
	Monte Dolack Gallery
	Open Road Bicycles
	UM: EVST Department
	UM: Forestry Department
	UM: Education Department
	UM: Art Department
	UM: University Center
	UM: Division of Biological Sciences/Avian Science Center

Appendix B. Common species of cavity-nesting birds in coniferous forests of Western Montana.

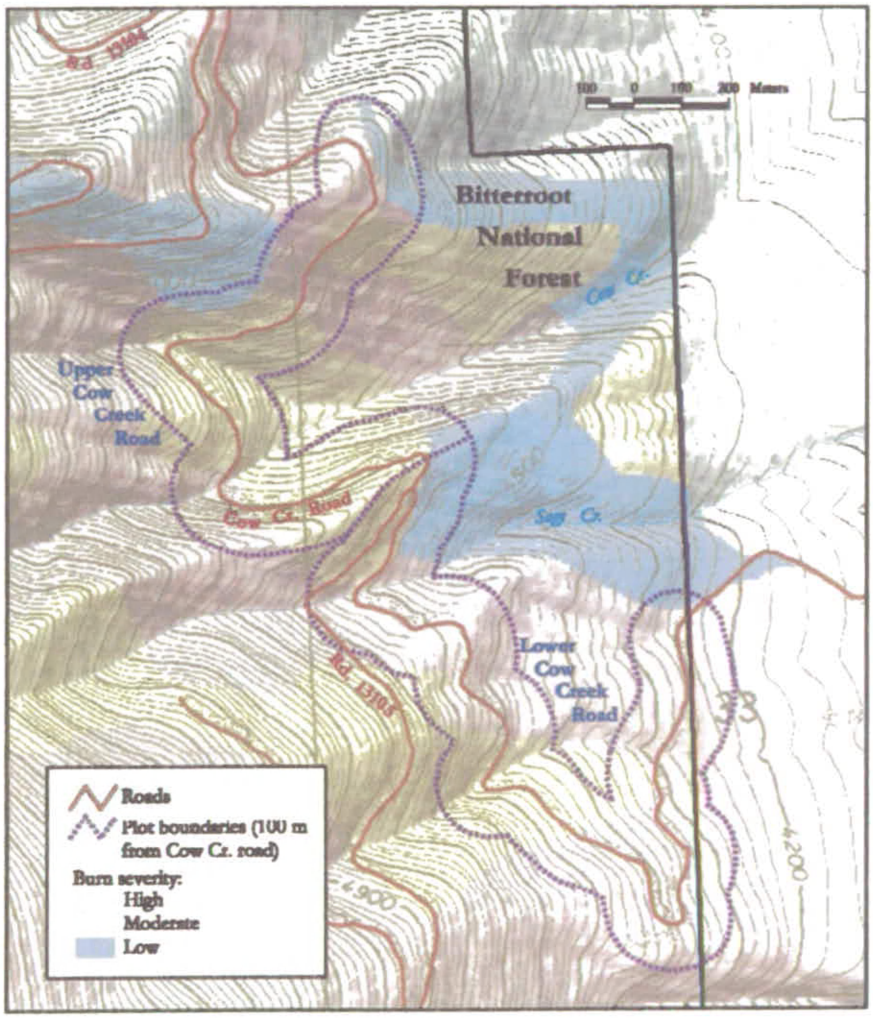
Common name	Scientific name	AOU[1] acronym
American kestrel	*Falco sparverius*	MAKE
Flammulated owl	*Otus flammeolus*	FLOW
Northern saw-whet owl	*Aegolius acadicus*	NSWO
Lewis's woodpecker	*Melanerpes lewis*	LEWO
Red-naped sapsucker	*Sphyrapicus nuchalis*	RNSA
Williamson's sapsucker	*Sphyrapicus thyroideus*	WISA
Downy woodpecker	*Picoides pubescens*	DOWO
Hairy woodpecker	*Picoides villosus*	HAWO
Three-toed woodpecker	*Picoides tricdactylus*	TTWO
Black-backed woodpecker	*Picoides arcticus*	BBWO
Northern flicker	*Colaptes auratus*	NOFL
Pileated woodpecker	*Dryocopus pileatus*	PIWO
Black-capped chickadee	*Parus atricapillus*	BCCH
Mountain chickadee	*Poecile gambeli*	MOCH
Red-breasted nuthatch	*Sitta canadensis*	RBNU
White-breasted nuthatch	*Sitta carolinensis*	WBNU
Pygmy nuthatch	*Sitta pygmaea*	PYNU
House wren	*Troglodytes aedon*	HOWR
Western bluebird	*Sialia mexicana*	WEBL
Mountain bluebird	*Sialia currucoides*	MOBL
European starling	*Sturnus vulgaris*	EUST

[1] American Ornithologists' Union

Appendix C. Volunteer field methods manual table of contents

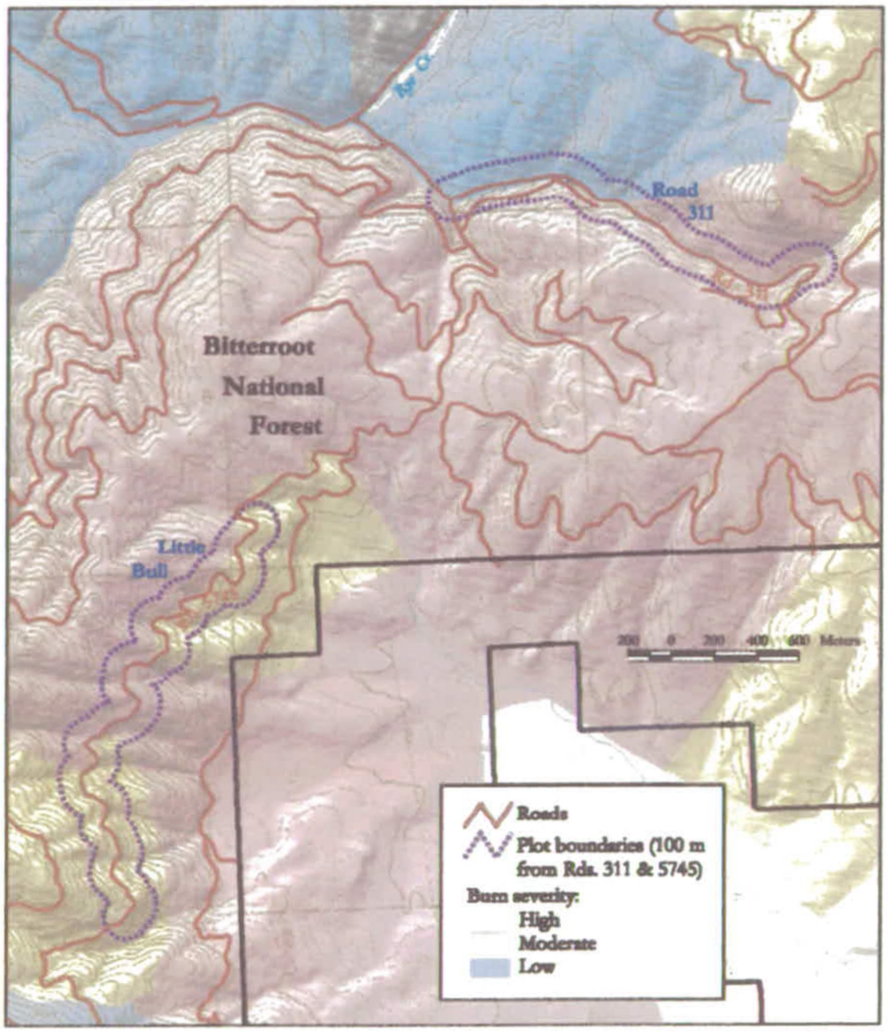
Map 1

Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Blodgett Fire Study Site



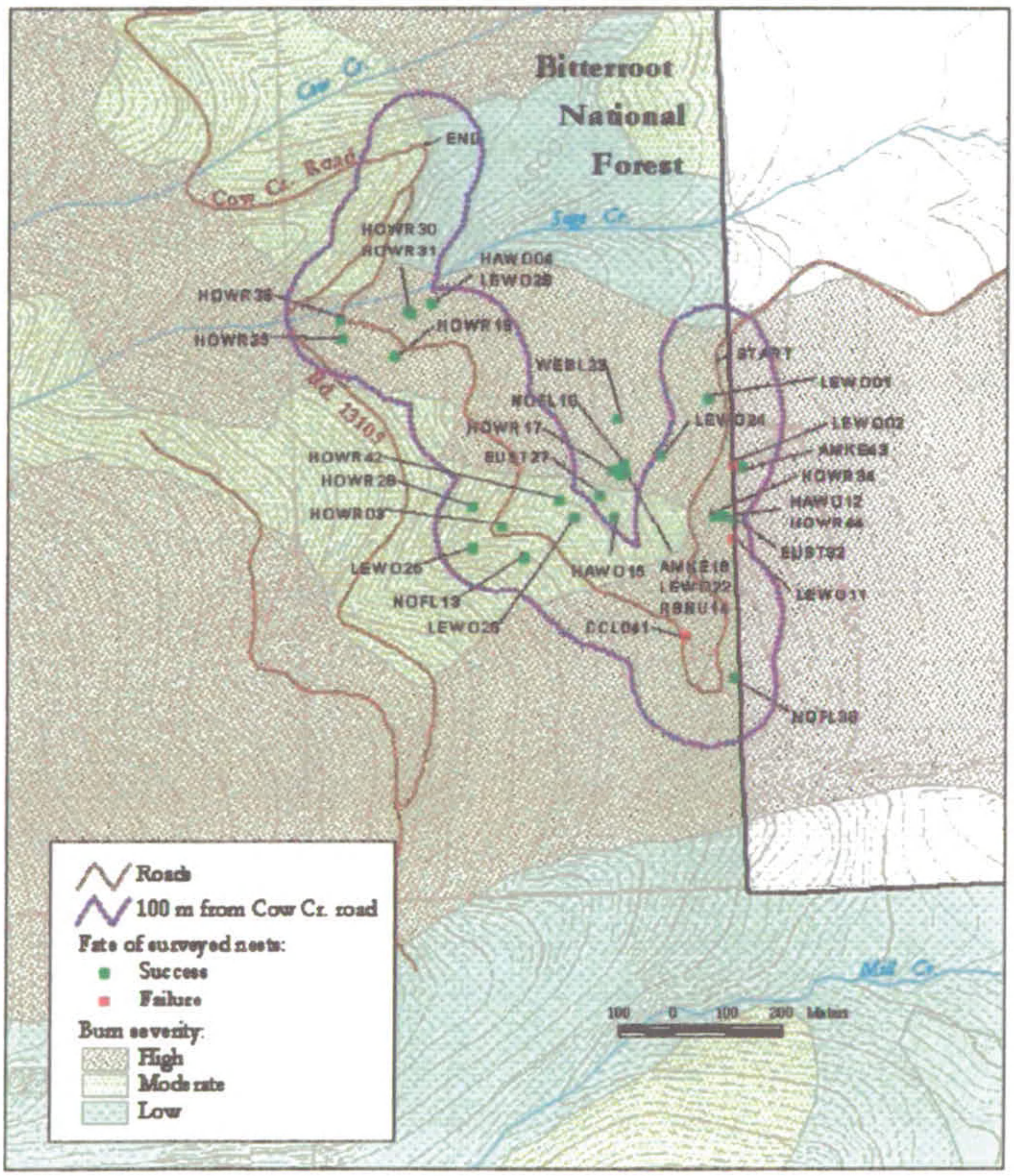
Map 2

Map 2: Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Skalkaho/Rye Study Site



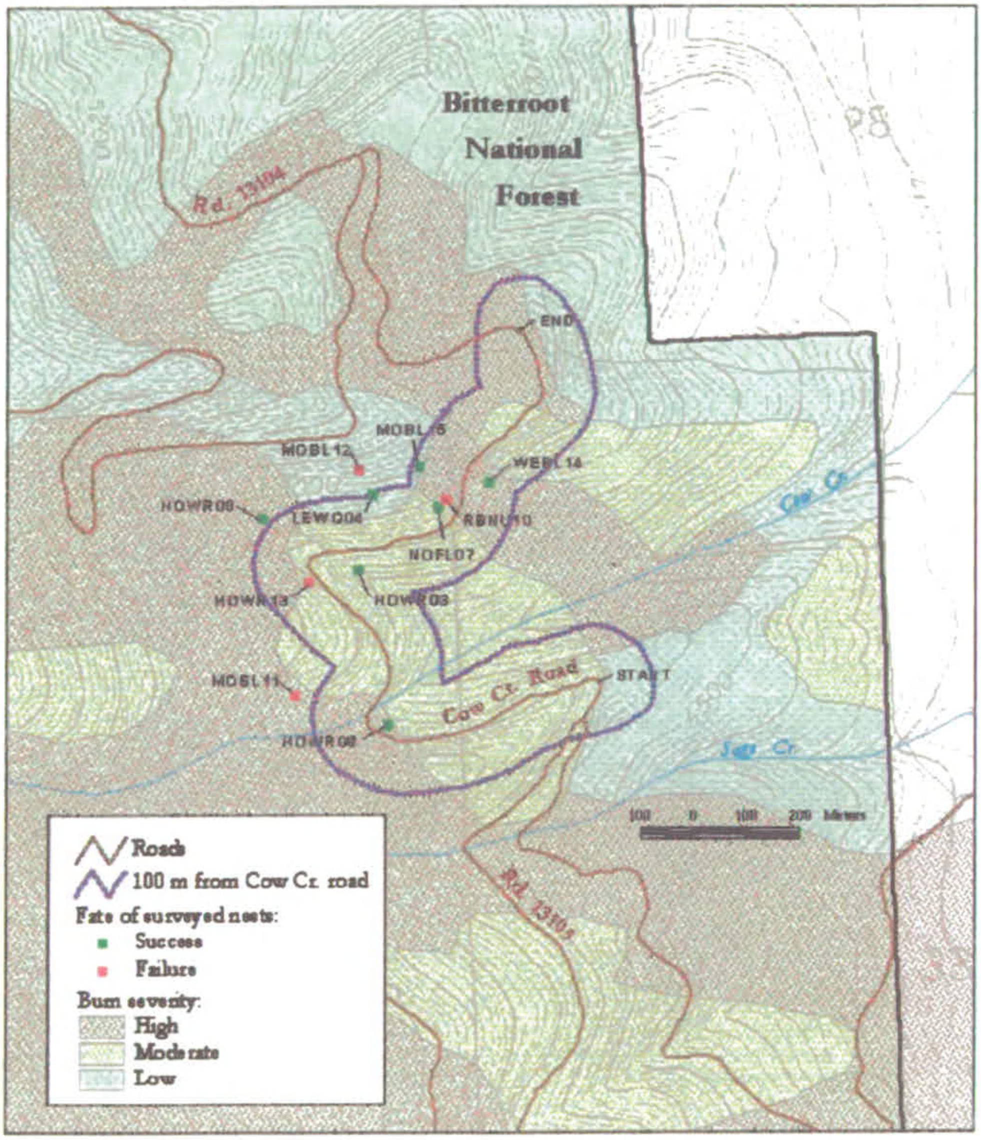
Map 3

Map 3: Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Cow Creek Lower - Logged



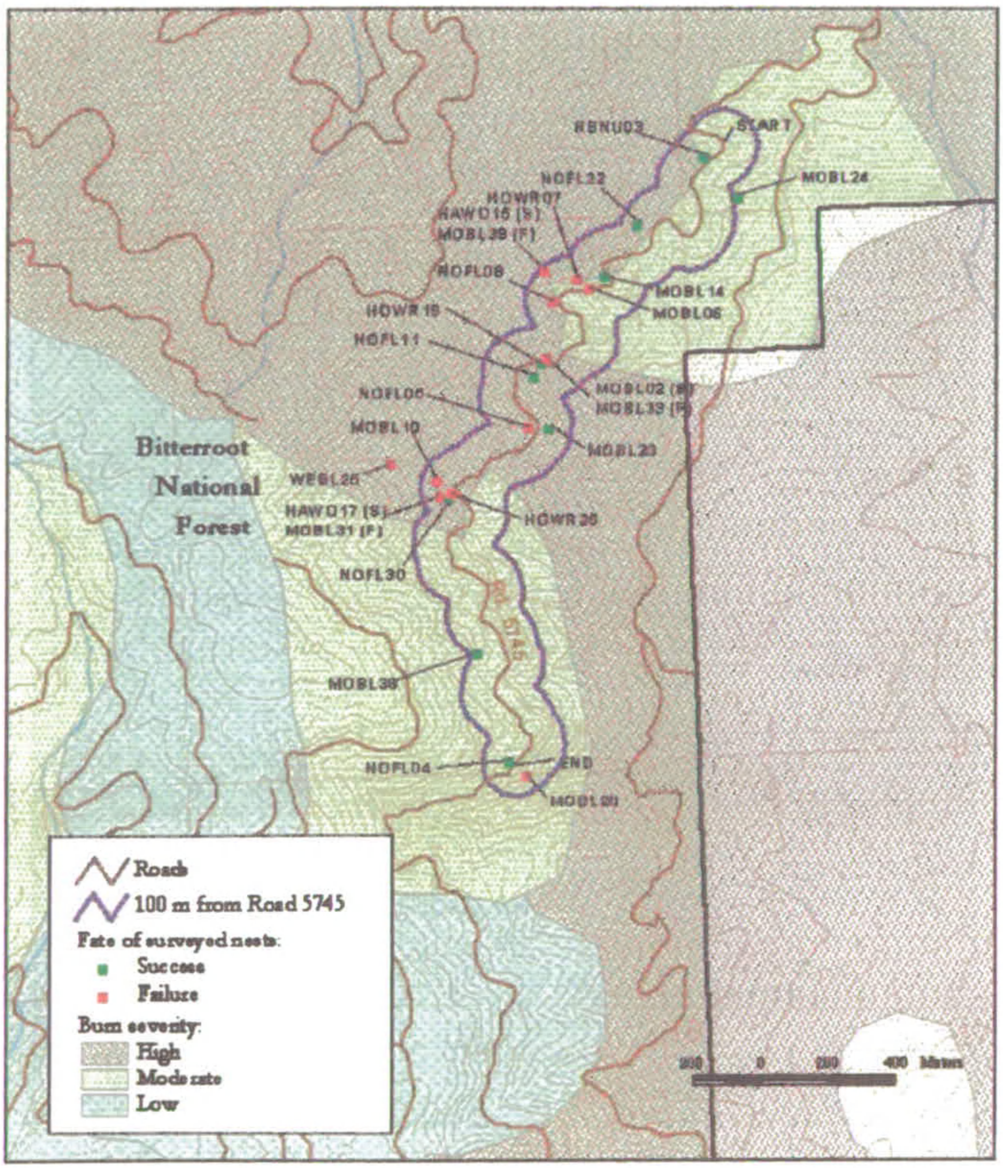
Map 4

Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Cow Creek Upper - Unlogged



Map 5

Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Little Bull - Logged



Map 6

Montana Audubon Citizen Based Monitoring Program
2004 Cavity-nesting Bird Surveys in the Bitterroot National Forest, Montana
Road 311 - Unlogged